ProHeatPump

Promotion of efficient heat pumps for heating

(ProHeatPump)

EIE/06/072 / S12.444283

Deliverable N° 18

Case Study on Renewables and Heat Pumps

GRETh

Work Package 5
Heat Pumps and Renewables

Intelligent Energy Europe

Editor: Bernard Thonon

Summary

This report compiles 9 case studies collected by the partners on the combination of heat pumps with renewable heating and cooling energies and for reversible heat pumping system.
Despite a very important scientific literature (more than 100 references collected) and several industrial companies proposing combined system, there is only limited information available on the combination heat pumps with RES providing technical and economic data.

The case studies are related to:

- ◊ Heat pump and PV system (two cases)
- ◊ Reversible heat pumping (two cases)
- ◊ Heat pump with solar heat (two cases)
- ◊ Solar driven absorption heat pump (two cases)
- ◊ Wastewater heat pump (one case)

BEST PRACTICE EXAMPLE

Heat Pump and Reversible Air-Conditionning

Reversible Air-Source Heat Pump

General Description

Country	FRANCE
City	Lyon
Client name	ALLP
Application area	Building sector
Building type	Office Building
Year of construction	1974 retrofitted in 2008
Heat pump type	Reversible air-source heat pump
Year of installation	2008
Refrigerant	
Operation mode	
Purpose	Cooling/heating
Heat source system	Ambient air
Contact name	David Corgier
Contact E-mail	David.corgier@cea.fr
Contact website	http://www.genhepi.com/
Supported by	

Summary

SITE AND CLIMATIC CONDITIONS

Location	**Lyon, FRANCE**
Latitude; Longitude; Altitude	**45°N, 8.5°E, 176 m**
Mean annual temperature	**12.3°C**
Mean winter temperature	**6°C**
Winter design temperature	**- 9°C**
Summer design temperature	
Summer design daily temperature excursion	

PRESENT BUILDING DESCRIPTION

Conditioned floor area	**2250 m²**
Conditioned building volume	**8114 m^3**
Numbers of conditioned floors	**3**
Building use	**Offices and storage (food and oxygen)**
Mean number of occupants	**90**
Period of construction	**1974**
Structure and envelope typology	**concrete skeleton structure consisting in posts, beams and slabs**
Occupation schedule	**From Monday to Friday (7 am to 19 pm)**

PRESENT PLANT DESCRIPTION

Plant typology	**Air / water heat pump (100 kW) + Gas boiler**
Heating power	**100 + 350 kW**
Cooling power	**100 kW**
Electrical power	
Mechanical ventilation	**HVAC Air water w/2 pipes FCU**
Other important plant characteristics	

RETROFIT CONCEPT

Renovation work (period, contract, etc.)	**6 months of work (2007 may to December)**
Intervention on building services	
Intervention on building structure and envelope	**External insulation of walls & roof, performing glazing**
Renovation costs	**€**

PREVIOUS BUILDING / PLANT DESCRIPTION

Initially, the building was equipped with a gas boiler. Comfort conditions in summer time were not acceptable for occupants.
A first energy audit was performed to evaluate the air conditioning plant to be installed without enevloppe retrofitting. The results were :

- **Chiller power :** **284 kW**
- **Estimated energy consumption :**

ENERGY MONITORING

Monitoring period	**3 years (minimum)**
Monitored quantities	**100 variables**
Instrumentation used	**BEMS extension**
Main results	**Energy consumption, Heat Pump efficiency and comfort evaluation and verification**

ENERGY SIMULATION

Model / code used	**TRNSYS 16**
Goals of the simulation	**Materials choice and system architecture validation**
Main results	**Heat pump sizing on the basis of cooling need** **Energy consumption evaluation for economical payback study**

LESSONS LEARNED

System Design
System Operation and Maintenance
Energy performance
Comfort level
Occupants evaluation
Missing points
Future developments

KEY SUBJECTS

BEST PRACTICE EXAMPLE

Heat Pump and Reversible Air-Conditionning

Reversible Air-Source Heat Pump

General Description

Country	FRANCE
City	Annecy
Client name	CAUE
Application area	Building sector
Building type	Office Building
Year of construction	2008
Heat pump type	Reversible ground-source heat pump
Year of installation	2008
Refrigerant	
Operation mode	
Purpose	Cooling/heating
Heat source system	Ground
Contact name	David Corgier
Contact E-mail	David.corgier@cea.fr
Contact website	http://www.genhepi.com/
Supported by	

Summary

SITE AND CLIMATIC CONDITIONS

Location	**Annecy, FRANCE**
Latitude; Longitude; Altitude	**xx°N, 8xx°E, 176 m**
Mean annual temperature	**°C**
Mean winter temperature	**6°C**
Winter design temperature	**- 9°C**
Summer design temperature	
Summer design daily temperature excursion	

PRESENT BUILDING DESCRIPTION

Conditioned floor area	**550 m²**
Conditioned building volume	**xxxx m^3**
Numbers of conditioned floors	**4**
Building use	**Offices**
Mean number of occupants	**20**
Period of construction	**2008**
Structure and envelope typology	**concrete skeleton structure consisting in posts, beams and slabs**
Occupation schedule	**From Monday to Friday (7 am to 19 pm)**

PRESENT PLANT DESCRIPTION

Plant typology	**GSHP with radiant ceiling heating / cooling.**
Heating power	**30 kW**

Cooling power	**40 kW**
Electrical power	
Mechanical ventilation	**Mechanical ventilation with exhaust air heat recovery**
Other important plant characteristics	

RETROFIT CONCEPT

Renovation work (period, contract, etc.)
Intervention on building services
Intervention on building structure and envelope
Renovation costs

PREVIOUS BUILDING / PLANT DESCRIPTION

ENERGY MONITORING

Monitoring period	**3 years (minimum)**
Monitored quantities	**30 variables**
Instrumentation used	**BEMS extension**
Main results	**Energy consumption, Heat Pump efficiency and comfort evaluation and verification**

ENERGY SIMULATION

Model / code used	**TRNSYS 16**
Goals of the simulation	**Materials choice and system architecture validation**
Main results	**Heat pump sizing on the basis of cooling need** **Energy consumption evaluation for economical payback study**

LESSONS LEARNED

System Design
System Operation and Maintenance
Energy performance
Comfort level
Occupants evaluation
Missing points
Future developments

KEY SUBJECTS

BEST PRACTICE EXAMPLE

Heat Pump in Combination with RES

Heat Pump combined with a PV system

General Description

Country	BELGIUM
City	Ghent
Client name	n.a.
Application area	Building sector
Building type	One-/two-family house
Year of construction	2000
Heat pump type	heat pump
Year of installation	2000
Refrigerant	
Operation mode	
Purpose	heating
Heat source system	Ground source and exhaust air
Contact name	
Contact E-mail	
Contact website	http://www.leonardo-energy.org/drupal/node/2083
Supported by	

Summary

The following case study is the result of a discussion with Kurt Hellemans and provides a brief overview on the sustainable energy solutions he implemented in his house. The article is published as an eBook so you can scroll the different pages using the titles bellow. The full article is also available right.

Kurt works as an electricity and instrumentation designer for BNS Engineering. He lives with his wife Lieve and their two children, Ella (7 years old) and Pablo (5 years old), in a new house in Laarne near Ghent, in the Flemish part of Belgium.
It is a spacious home of 180 m2 with all of the usual appliances: an electric cooker, a fridge, a freezer, a dishwasher, a washing machine for laundry, a computer, and a television. The house even has a private sauna as a bonus. The tap water is supplied to the house from a rainwater cistern by an electric pump. Despite all of these electrical appliances, the total monthly energy bill of Kurt and his family is only €76.

Heat pump system

The heat pump circuit consists of copper tubes filled with Freon. In the low pressure, low temperature section of the circuit, the Freon flows into the wells and retains heat from the ground water (6 °C). It is then compressed by a 5.5 kW screw compressor to high pressure and high temperature. After giving off heat to the house, the Freon is expanded again and flows back into the wells.

Since the heat pump is combined with low temperature convection heating, good insulation is essential. To minimize the heat losses, Kurt opted for a system of forced ventilation with heat recuperation. Air is exhausted from the toilet, the bathroom, and the living room. Fresh air is injected, after being heated by the exhausted air, into the living room, the kitchen, and the bedrooms.
'The result is that we rarely need to put on the heating in the bedrooms,' explains Kurt. 'In the beginning, we had to get used to never opening the windows in wintertime. The ventilation system works a bit slower compared to wide open windows, but when I come home from work in the evening, bedrooms smell freshly ventilated and very little heat has escaped. During summer months we turn the ventilation system off and enjoy the pleasure of open windows.' The ventilation system fans have been soundproofed to avoid noise nuisance.

PV system

When the Flemish Government started granting subsidies for photovoltaic (PV) systems in 2005, Kurt did not hesitate and decided to install his own PV system. He also got a small extra grant from the community of Laarne, a tax exemption from the Federal Belgian Government, and his system yields green certificates. He could only receive subsidies for 2,400 W as a residential customer, but he opted to immediately install 3,840 W.
'During the design phase of the house, I had already decided to eventually install a PV system on the roof,' says Kurt. 'As you can see, the sloping

sections of the roof are not directed towards the street and the garden as you would normally expect, but rather towards the side of the house. One of the slopes faces south with only 2° of deviation.'

The PV system, installed on the south facing roof, consists of 24 panels of 160 W each from Shell and covers 30 m2. The cells are made of polycrystalline silicon and have a 25 year guarantee.

Kurt Hellemans: 'The most delicate parts of the system are the invertors. If their power is too low, they become too hot and will have a shorter life span. If their power is more than necessary, their efficiency goes down. I divided the panels into three sections and installed three invertors to generate three-phased electricity. That was the best option to keep my residential network balanced, since the heat pump compressor is also three-phase. The invertors have an efficiency of 95-98 per cent. I installed them in the attic to be as close to the PV panels as possible, because the DC side of the system has higher losses.'

'The system reaches its maximum production between eleven o'clock in the morning and three o'clock in the afternoon from April to September. On a nice sunny day, it can yield 22 kWh.' Generating his own electricity does not mean he is spared from power cuts on the grid. 'I can not use my photovoltaic system as an Uninterruptible Power Supply', says Kurt. 'It simply is not worth the additional cost to provide a UPS function. When the grid goes down, a safety switch cuts my system off and we are in the dark just like our neighbors.' And what if a power cut happens on a cold winter's day? 'Then the heat pump turns off and we have to do without the heating system. But thanks to the excellent insulation of our house, temperature goes down very slowly. In the past six years, we have never had any problems with that.'

Costs, economic efficiency, incentives

Kurt is not only putting effort in optimizing the energy technology. He also tries to adopt good habits to minimize consumption. By installing a few kilowatt-hour meters, he is able to monitor the consumption of each energy function in the house. 'This awareness helped us cut our consumption from 13,000 kWh per year to 9,500 kWh per year,' he explains.

Of this energy, he can generate 3,500 to 3,600 kWh with his own PV system. The remaining 6,000 kWh is supplied by the grid. This is less than one fourth of the 24,880 kWh the average Flemish household is buying from the electricity and natural gas utilities. And by purchasing 'green

electricity' from Nuon, which is generated by wind and hydro power, Kurt assured that his house is completely free of carbon emissions.
'Our total energy bill is only 76 € per month', he says. 'For the PV system, I calculated a pay-back period of 17 years. With the new incentives of the Flemish Government (without subsidies but with a higher price for green certificates) the pay-back period would only have been 10 years.'
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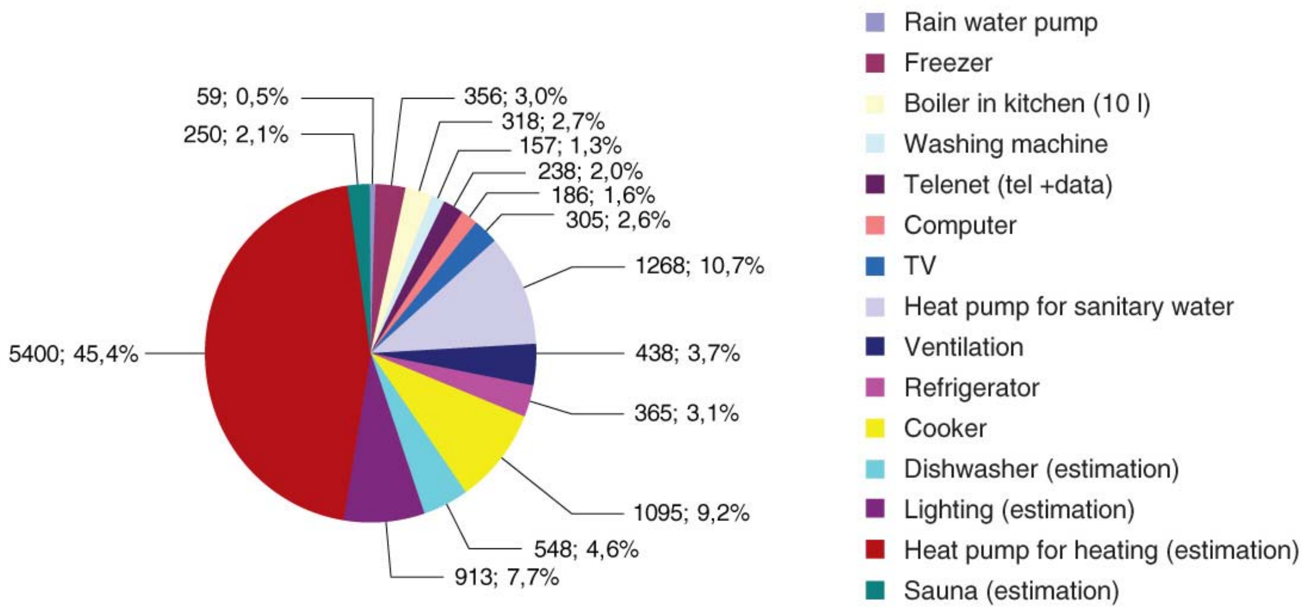


BEST PRACTICE EXAMPLE

Heat Pump in Combination with RES

Ground Source Heat Pump combined Solar Panels

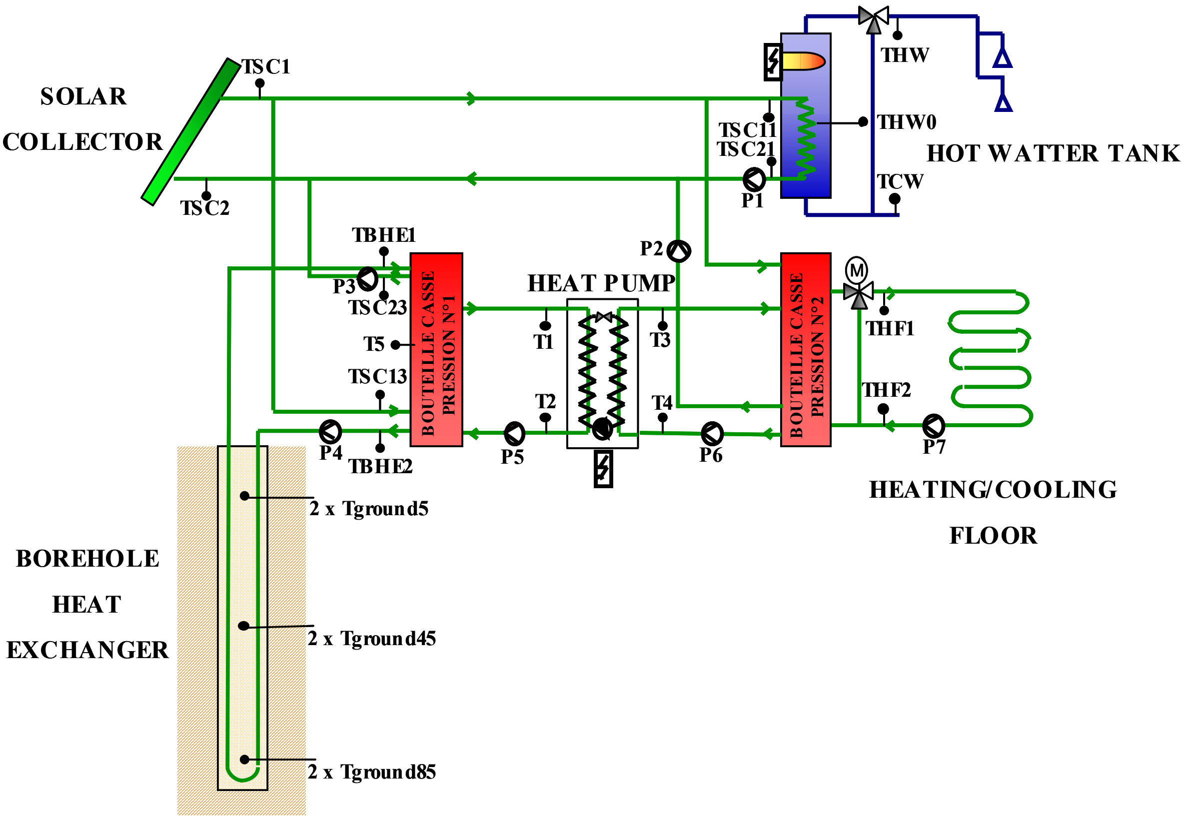
General Description	
Country	FRANCE
City	Saint-Jean d'Arvey (73)
Client name	n.a.
Application area	Building sector
Building type	One-/two-family house
Year of construction	2004
Heat pump type	Ground source heat pump
Year of installation	2004
Refrigerant	
Operation mode	
Purpose	Cooling/heating
Heat source system	Ground source and Solar energy
Contact name	
Contact E-mail	
Contact website	
Supported by	ANR and ADEME

Summary

The study discussed relates to the design and development of a process consisting of combining a reversible geothermal heat pump with thermal solar collectors for building heating and cooling and the production of domestic hot water. The proposed process, called GEOSOL, has been installed in a 180 m² private residence in 2004. This installation is the subject of long-term experimental follow-up to analyse the energy-related behavior of the installation at all times of the year. In addition, different configurations of this combined system (geothermal heat pump and thermal solar collectors) have been defined and will be simulated numerically using TRNSYS software. A comparative analysis of these different alternative versions will be conducted to determine the best configuration(s) of the GEOSOL process in terms of energy, economical and environmental performances.

Building, overall energy concept

The GEOSOL process is being testing under real conditions in a 180 m² single family house at St Jean d'Arvey in Savoie (France) since the autumn of 2004. The main characteristics of the installation are as follows: two double-U borehole heat exchangers 90 m long; 12 m² of rooftop thermal solar collectors, this surface area is oversized with respect to the domestic hot water requirements alone so that the excess solar energy production is routed to the floor heating or to the boreholes to favour thermal ground recovery; a reversible heat pump with an heating power of 15,5 kW (CIAT Auréa ILA Z60); a 500 liters combined solar / electrical hot water tank ; a low-temperature floor distribution system ; the water-antifreeze mixture (35% glycol solution, antifreeze to -18°C) circulates throughout the installation.



Operation experiences

During the first possible operating sequence, the solar collectors are involved in domestic hot water production and, in addition, the geothermal heat pump meets the building's heating or cooling requirements. During the second possible sequence, the solar energy produced is injected directly into the low-temperature heating floor (direct solar floor heating principle) or, if the temperature level is insufficient, it may be used to supply the heat pump cooling source to improve its COP. Finally, the third possible operating sequence consists of recharging the soil via solar collectors or meeting the building's cooling requirements by the reversible heat pump..

Costs, economic efficiency, incentives

The combination of renewable energies such as thermal solar energy and geothermal energy in a single system should make it possible to meet heating, cooling and hot water requirements, while guaranteeing a satisfactory level of comfort and quality of use under all circumstances.

The project developed is indicative of the determination of the industrial partners working together to design new energy systems in line with current technical, economical and environmental constraints, aiming to reduce greenhouse gas emissions and, more generally, have sustainable operating system.

The end purpose of our GEOSOL is to offer an alternative technical solution which helps reduce operating costs compared to those generated by conventional solutions using fossil energies. In addition, our solution initially devised for private dwellings may be extended to collective dwellings and the tertiary sector. For these two types of application, thermal solar collectors could help reduce the number of boreholes and the investment cost of the installation.

Regulations, guidelines, benchmarking

No data available.

References

No data available.

CONTRIBUTION SWB NETZE TO DELIVERABLE D 18

WP5: heat pumps and renewable energy sources

Workpackage 5 deals with using heat pumps in combination with renewable energy sources. The required variants to evaluate are shown below.

Evaluation of commercial products combining heat-pump with another renewable energy sources.

- Heat pump and solar thermal
- Multifunctional units
- Gas driven heat pumps using biogas engine
- Absorption heat pumps driven by biogas
- Photolvoltaic and heat pump coupling.

During the interventions of the project in the target area there has not been found any of the shown variants. After the interviews with important market players it seems that none of the roughly 180 heat pump units is used in combination with renewable energy sources.

Heat pump and solar thermal

A heat pump with solar thermal is not known by the interviewees. If people think about reducing their heating costs they think about using a heat pump or using condensing gas boilers and solar thermal systems in addition. They are often limited by the investment. Installing a heat pump and solar thermal is too expensive for most users. So when an old gas boiler is broken they decide to install a new gas boiler with a solar thermal addition.

Gas driven heat pumps using biogas engine

An installed unit with these properties is not known by the interviewed market players.

There are some obstacles that hinder user who want to create such a heat pump unit. Using gas driven heat pumps with biogas in Germany is forbidden by their manufacturers and the operating licence could be detracted. The quality of biogas is evaluated not high enough and the engine could be damaged while using biogas.

Absorption heat pumps driven by biogas

The interviewed persons could not name a unit with these parts. There is an absorption heat pump which is driven by electricity that uses solar thermal for cooling. The unit is described in the separate document “absorptionheatpump_zz_28072008”.

Photolvoltaic and heat pump coupling

There are properties where photovoltaic panels and heat pumps are installed but they are not combined to drive a heat pump to cover the heat demand. Due to high grants for electricity that is produced by photovoltaic it is charged into the grid. The payment for photovoltaic electricity is about 45ct/kWh in 2008. The price of electricity from the grid is roughly 20 ct/kWh for private bodies and between 5 and 15 ct/kWh for companies. A change of this attitude is not in sight as long as there are grants like these.

CONTRIBUTION PARTNER 8 swb NETZE TO DELIVERABLE D 18 (2)

Absorption heatpump at ZentrumZukunft of EWE AG

Common description	
Country	Germany
City	49685 Emstek
Street	Europa-Allee 2
Constructor	EWE AG
Mainuser	Administration building
Completion	2008
Cooling	Absorption heat pump
Refridgerant fluid	water
Solvent	Lithiumbromid
Heat source	Vacuum tube collectors
Contact person	Dipl.- Ing. Hans-Gerd Funke
E-mail	hans-gerd.funke@ewe.de
Website	http://www.zentrumzukunft.de

The project: ZentrumZukunft

The ZentrumZukunft (www.zentrumzukunft.de) is an education and conference centre of EWE AG at the ecopark in Emstek. There are three sections: the vision energy section, training room and the three-storey living.

The energy is supplied by the section vision energy. This is assured by foreward-looking technology like for example a heat pump or an absortion chiller.

Visitors can experiance the prospective technical development in the living sector during a tour through the vision living. There is shown how environment saving use of energy and growing comfort could be combined.

The building was openend on March 11th, 2008. EWE would like to provide topics like energy efficiency and new technologies to important market actors. Main target groups are Installers, architects and engineers, schools and universities as well as local authorities and further organisations.

The absorption chiller (middle of picture) is implemented in vision energy. Next to this unit for example for solar cooling further units for heating, cooling and generating electricity are presented.

The vision living is placed as a three-storey glass cube into the centre building.

The functional principle

The single-stage absorption chiller has been developed by SK SonnenKlima GmbH. The chiller uses two climate-neutral operating materials, Lithiumbromid and distilled water. The functional principle is quite simple:

The conducted operating power causes evaporation to separate the refrigerant fluid water and lithiumbromid. The refrigerant fluid water is fluidised in the condenser. Due to depression the water is cooled down strongly and is able to collect heat by a cooling element – the room is cooled. The absorbed heat is conducted to the environment via the cooling tower.

There are some considerable advantages of this new designed absorbtion chiller compared to other available absorbtion chillers. The unit works with low temperature heat (from 55°C). This level of temperature can be provided by for example waste heat, solar collectors or district heating. In this case vacuum tube collectors are in use.

Evaluation of profitability

Due to the short-term operation of the centre there is no evaluation of profitability done yet.

The manufactorer

SK SonnenKlima GmbH

Am Treptower Park 28-30

D-12435 Berlin

Tel: 030/530007-700

Fax: 030/530007-17

E-mail: info@SonnenKlima.de

Website: [http://www.sonnenklima.de]

Technical data

Spezifikationen		Einheit	***sun**inverse*	
			Betrieb mit Kaltwasser-konvektoren	Betrieb mit Kühldecken
Kälteleistung nominal/maximal		kW	8,8 / 11,7	10 / 15,8
		USRT	2,5 / 3,3	2,8 / 4,5
		BTU/h	30026 / 39932	34120 / 53925
Kaltwasser-kreislauf	Temperatur nominal/maximal (aus - ein)	°C	6-12	15-18 / 15-20
	Volumenstrom nominal/maximal	m³/h	1,3 / 1,7	2,9
	Druckverlust intern	mbar	350	
	Anschluss		1 ½" AG, flachdichtend	
Heißwasser-kreislauf	Temperatur nominal/maximal (ein)	°C	85 / 95	75 / 95
	Volumenstrom nominal/maximal	m³/h	1,2	1,2
	Druckverlust intern	mbar	200	
	Anschluss		1 ¼" AG, flachdichtend	
Kühlwasser-kreislauf	Temperatur nominal/maximal (ein - aus)	°C	35-27 / 36-27	35-27 / 39-27
	Volumenstrom nominal/maximal	m³/h	2,6	2,6
	Druckverlust intern	mbar	320	
	Anschluss		1 ½" AG, flachdichtend	
Elektrischer Anschluss	Spannung	V	230 V ~ 1 ph 50Hz	
	Lösungspumpe	W	70	
	Kältemittelpumpe	W	50	
Abmaße	Höhe H	mm	1960	
	Breite B	mm	1130	
	Tiefe T	mm	795	
Gewicht	Betrieb	kg	550	
	Transport	kg	500	

Änderungen vorbehalten

ProHeatPump

Intelligent Energy Europe

Best practice example

Heat pump in combination with RES:

Heat pump using waste heat from wastewater

General Description	
Country	Sweden
City	Alvesta
Client name	Alvesta municipality
Application area	Building sector
Building type	Wastewater treatment plant
Year of construction	-
Heat pump type	Electrical heat pump
Year of installation	2002
Refrigerant	R134a
Operation mode	
Purpose	Heating
Heat source system	Wastewater
Contact name	Håkan Nyström
Contact E-mail	Hakan.nystrom@alvesta.se
Contact website	http://www.alvesta.se

ProHeatPump

Intelligent Energy Europe

Summary

The heat pump system is located at Alvesta wastewater treatment plant, Sweden. By using waste heat from the wastewater treatment plant the municipality can decrease their use of oil for heating purposes. Using wastewater with a higher temperature, the efficiency of the heat pump increase. A new more efficient heat pump was installed in 2002 and has decreased the oil consumption with 50 to 60 m^3 per year.

Building, overall energy concept

The heat pump system cover parts of the heating load at the plant and a first heat pump was installed in 1981 in order to decrease costs and oil consumption.

About 5000 m^3 of water passes through the sewage treatment plant every day and parts of the purified water is used in the heat pump system.

The primary heat source at the plant is biogas. The heat pump is used as secondary heat source and as third alternative an oil boiler supplies the processes with heat.

In 2002 the old heat pump was replaced with a new one. Due to more efficient compressors the oil consumption decreased with 50-60 m^3 per year.

Heat pump system

The heat pump is a water-cooling unit with four compressors.

Model: CIAT LG1000

Refrigerant: R134a

The heat pump uses purified wastewater, which has a temperature of 8-9 degrees during wintertime before the heat pump and around 4-5 degrees after. The heat pump delivers hot water to the heating system at about 55 degrees.

To secure the water flow through the heat pump the filters need to be cleaned every week.

Operation experiences

The heat pump replaces oil and approximately 50 to 60 m^3 was saved and the CO2-emmissons reduced with 160 tons due to the new heat pump.

The motivation to the investment was primary due to economical reasons. The management of the sewage treatment plant is very pleased with the heat pump system and have plans to install heat pumps at two other plants as well.

Costs, economic efficiency, incentives

Investment cost to replace the old heat pump was approximately 38 000 €. Total cost for each produced MWh heat are today one third of the electricity price (COP = 3), maintenance is very little approximately 5-600 € per year.

Characteristic values, performance data

	Design value
Heating capacity (kW)	250
COP (Heating, appliance) [2]	-
SPF (Heating) [3]	-
Annual heat delivery (kWh/year) [4]	-

Contacts, Links

Institution/company	Alvesta municipality
Responsibility/function	
Street/PoBox	Centralplan 1
City code	342 80
City	Alvesta
Country	Sweden
Contact person	Håkan Nyström
Website (URL)	http://www.alvesta.se

Best practice example

Heat pump in combination with RES:

Heat pump using electricity produced with solar cells

General Description	
Country	Sverige
City	XXX
Client name	XXX
Application area	Building sector
Building type	One-family house
Year of construction	2006
Heat pump type	Electrical heat pump
Year of installation	2006
Purpose	Heating
Heat source system	Ground source heat pump
Contact name	Richard Nilsson
Contact E-mail	richard.nilsson@ekosolenergi.se
Contact website	www.ekosolenergi.se

Summary

A single-family house can get very low heating costs by using solar cells. The solar cells are placed on the roof of the house and produce electricity, which is used in the house and also for a heat pump. Surplus of electricity is delivered to the grid and can be bought back when the solar cells doesn't produce enough.

Building and energy system

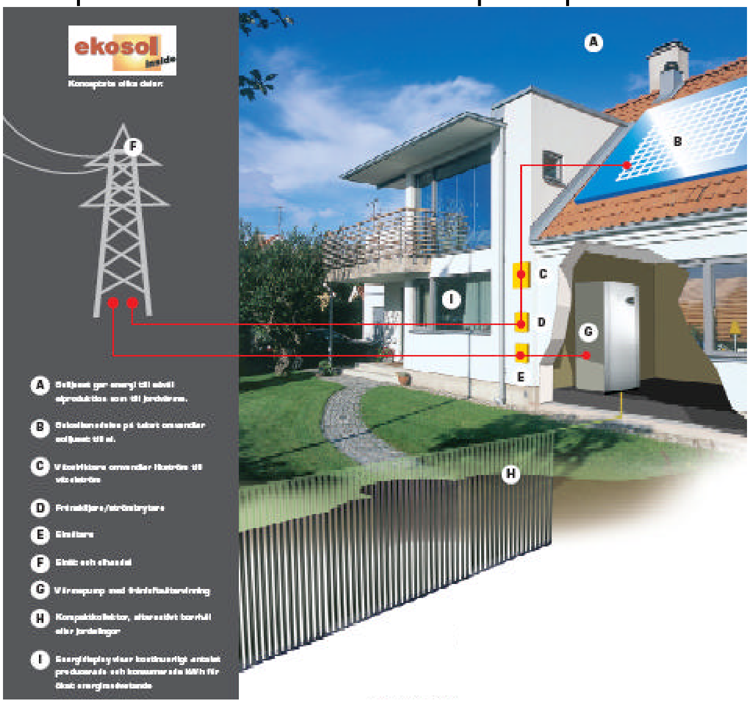
The solar cell modules are placed on the roof and produces renewable electricity. A separate electricity meter display the amount of electricity produced and also the amount delivered to the grid.

The solar cell modules are 1,3 m^2 each and produces about 162 W. To deliver 6 kW about 48 m^2 is demanded, which corresponds to a production of 5000 kWh per year.

The solar cells are combined with a heat pump from IVT that collect heat from the ground and supply the house with heat and hot water. The amount of electricity produced by the solar cells corresponds to the electricity demand for the heat pump. The cost for the house owner to produce heat and hot water is therefore almost zero.

Another company, Ekosol, rents the solar cell plant from the house owner. Ekosol sells the produced electricity on the market in cooperation with the local energy company.

The picture below shows the principle



Source: www.ekosolenergi.se

Heat pump system

The heat pump collects heat from the ground. It is an ordinary heat pump system except that the electricity comes from solar cells.

Operation experiences

It is necessary to come to an agreement with the local energy company since it must be possible to deliver surplus of electricity to the grid.

Contacts, Links

Institution/company	**Ekosol**
Responsibility/function	Coordinator
Street/PoBox	Torslanda Torg 1
City code	423 32
City	Torslanda
Country	Sverige
Contact person	Richard Nilsson
E-mail	richard.nilsson@ekosolenergi.se
Website (URL)	www.ekosolenergi.se

Contacts, Links

Institution/company	**IVT Industrier AB**
Responsibility/function	Manufacturer
Street/PoBox	Box 1012
City code	573 28
City	Tranås
Country	Sverige
Website (URL)	www.ivt.se

Contacts, Links

Institution/company	**Sharp**
Responsibility/function	Manufacturer
Street/PoBox	Box 14098
City code	167 14
City	Bromma
Country	Sverige
Website (URL)	www.sharp.eu/sv-se

Best practice example

Heat pump in combination with RES:

Heat pump combined with solar heat

General Description	
Country	Sweden
City	XXX
Building type	One family house
Year of construction	XXX
Year of installation	XXX
Heat pump type	Electrical heat pump
Purpose	Heat and hot water production
Heat source system	Ground and solar panels
Contact name	Ronney Krantz
Contact E-mail	ronney.krantz@evi.se
Contact website	www.eviheat.se

ProHeatPump

Intelligent Energy Europe

Summary

The single-family house is heated with a ground source heat pump in combination with total 15 m^2 solar panels. The heat pumps and the solar panels cover the total heat and hot water demand for the house. After installation of the solar heat pump the energy demand for the family decreased from 27 000 kWh to 4 600 kWh per year.

The family consists of two adults and four children.

Heat pump system

The heat pump is a EVIHEAT SPLIT SUN 7 and collects heat from the ground and the solar panels. The system operates different depending on how much heat the house need and also on how much heat the solar panels produce at the moment.

The operation of the solar panels can be described in four modes. In mode 1 to 3 the solar panels deliver heat.

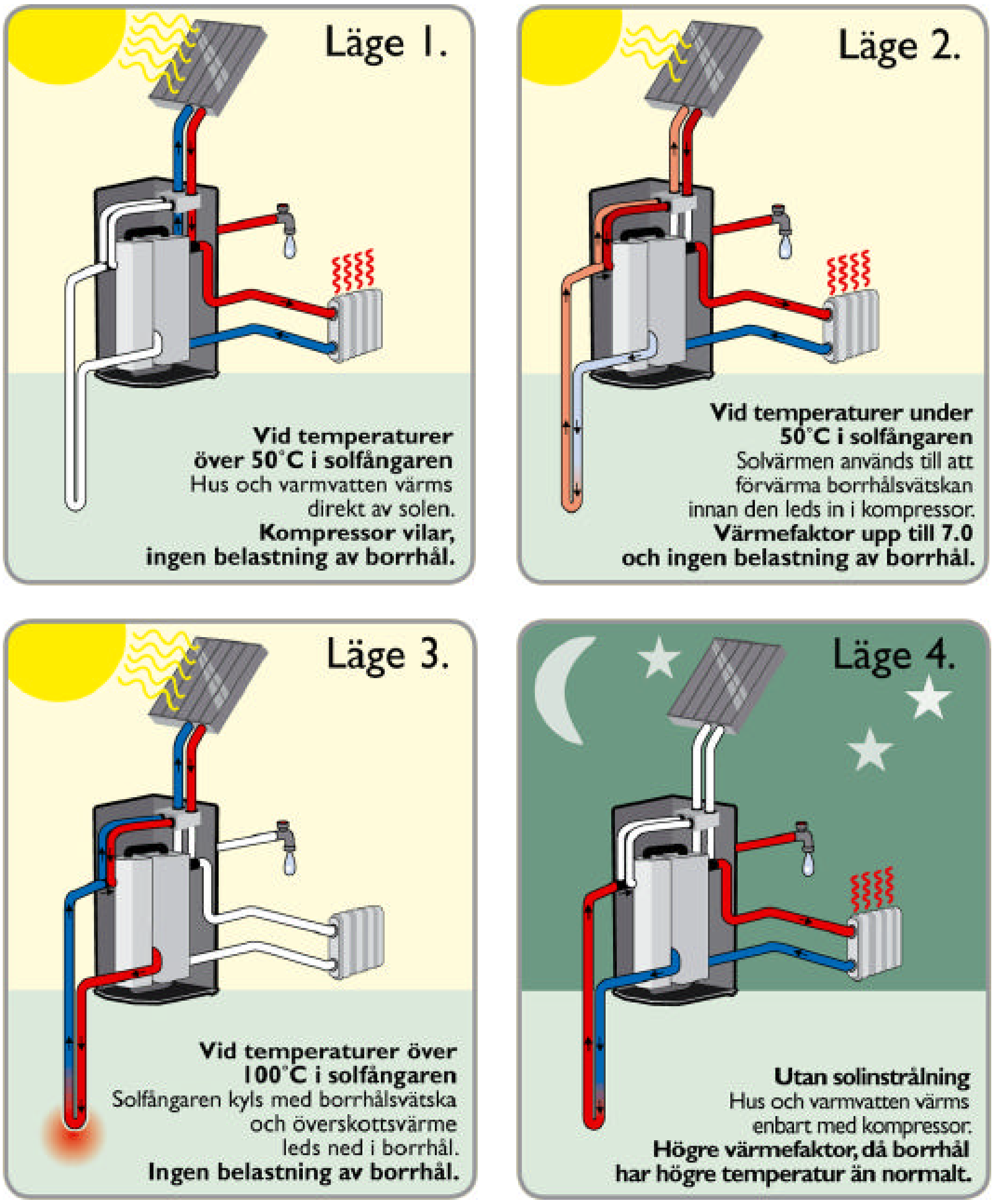
1: The solar panels deliver enough to cover both heat and hot water demand. Heat pump turned off.

2: Heat pump running. The refrigerant is heated in the ground but also further heated in the solar panels to get a better heat efficiency.

3: No heat demand. Surplus of heat from solar panels heat the ground and this heat can partly be recovered later.

4: No contribution of solar heat. House and hot water only heated with heat pump, but recover stored heat from the ground.

Pictures below shows the four different running modes.



Source: www.eviheat.se

Operation experiences

Use of primary energy decreased from 27 000 kWh to 4 600 kWh after the installation.

Twelve o'clock February 28 in 2008 the return temperature from the solar panel was 73° Celsius, which show that the solar panel also give some heat contribution during wintertime.

Contacts, Links

Institution/company	**Eviheat**
Responsibility/function	Manufacturer
Street/PoBox	Box 55
City code	196 22
City	Kungsängen
Country	Sverige
Contact person	Ronney Krantz
E-mail	ronney.krantz@evi.se
Website (URL)	www.eviheat.se

ProHeatPump

Intelligent Energy Europe

Best practice example

Heat pump in combination with RES:

Solar driven heat pump

General Description	
Country	SPAIN
City	Madrid
Client name	n.a.
Application area	Building sector
Building type	One-/two-family house
Year of construction	1988
Heat pump type	Absorption heat pump
Year of installation	2007
Refrigerant	
Operation mode	
Purpose	Cooling/heating
Heat source system	Solar energy
Contact name	Martin Holmström
Contact E-mail	info@climatewell.com
Contact website	http://www.climatewell.com

Source: ClimateWell AB

Summary

By using solar energy this detached house in Madrid is supplied with cooling and heating. The solar energy can be used for air conditioning, pool heating, for hot water during summer and for floor heating and hot water during winter period.

Photo: Climatewell

Building, overall energy concept

The house is a detached house built in late 1980 and located in Madrid in Spain. The main purpose of the heat pump is to produce cooling, but in order to use the machine as efficient as possible it is also used for heating.

The house is equipped with solar collectors and a radiant floor heating and cooling system. Standard components were used to minimise investment costs.

Photo: Climatewell

The house is not oriented towards the south so the solar collectors have been placed on a pergola in the garden. The house is powered by 33 m^2 of the SunTechnics STK1800 solar collector.

Heat pump system

Photo: Climatewell

The cooling and heating unit is a kind of chemical heat pump and has also the possibility to store both heat and cold. The heat pump operates in three modes; charging, heating and cooling. Charging is done in a chemical process where energy is stored by drying lithium chloride, which makes it different from an absorption machine using lithium bromide. By using lithium chloride the process becomes less sensitive to lower temperatures, which can be the case with solar energy. The machine can charge and discharge heat and cold at the same time.

It is necessary to have a heat sink for the process, and during summer when producing cold in this house the surplus of heat is used to heat the swimming pools. One alternative is also to use a cooling tower to get rid of the heat surplus, but by heating the pool the heat becomes useful.

Since the machine can store heat and cold the system is less sensitive for periods when the sun isn't shining. The storage possibility also makes this machine different from an ordinary absorption heat pump.

Mode	Storage Capacity*	Maximum Output Capacity**	Electrical COP ***	Thermal Efficiency
Cooling	**60 kWh**	**10/20 kW**	**77**	**68%**
Heating	**76 kWh**	**25 kW**	**96**	**160%**

* Total storage capacity (i.e. including both barrels)
** Cooling capacity per barrel: 10 kW cooling is the maximum capacity. If both barrels are used in parallel (double mode) the maximum cooling output is 20 kW and the maximum heating output is 25 kW.
*** Coefficient of Performance (COP) = cooling or heating output (kW) divided by electrical input. The only electrical input is 4 small circulation pumps and internal controls. COP in conventional compressor-based chillers and packaged air conditioning units are usually stated as cooling capacity (kW) divided by compressor electrical input. Since the ClimateWell 10 doesn't have a refrigeration compressor, COP is stated here as annual cooling/heating energy delivered divided by total electrical input of the pumps and internal controls.

Contacts, Links

Institution/company	**Climatewell**
Responsibility/function	
Street/PoBox	Instrumentvägen 20
City code	126 53
City	Hägersten
Country	Sweden
Contact person	Martin Holmström
Website (URL)	http://www.climatewell.com